Color Measurement

PROZESS TECHNOLOGIE

APPLICATION NOTES

Detector: UV-VIS (ultraviolet-visible 200–850 nm)

HIGHLIGHTS

- Millisecond measurement times
- Internal referencing, wavelength and linearity validation for stable, continuous operation
- WiFi, Ethernet, OPC, ModBus, Ethernet/IP communications standard
- CIELAB, CIELUV, XYZ Tristimulus, XYZ Chromaticity, RGB, Saybolt, or custom color space outputs
- Hazardous area enclosure options
- Various sampling options

Summary

Of all the properties measured during industrial processes, color is easily the most intuitive. For even subtle color variations, our eyes are keenly perceptive to hue and shade. For this reason, color is often ascribed a bulk determinant of product quality, whether inspecting the colorlessness of a polyethylene bottle for water packaging or the golden shading of refining products. But our eyes do not possess the sensitivity and precision necessary for industrial process controls, and our perception of color is heavily biased by the lighting conditions where the observation is taking place. For this reason, more sophisticated color analyzers are widely implemented throughout most industries.

Color analyzers fall into two main groups: colorimeters that measure three discrete wavelength bands to assign a color estimate, and spectrophotometers that measure the continuous spectrum of light throughout the human visual perception space and convert these continuous spectra into color. Assignment of "color" is then performed in a variety of color spaces, which are mathematical constructs that combine the multiple wavelength measurements into a color descriptor. For example, colorimeters often express output in RGB color, which uses red, green, and blue wavelength bands as descriptors. In refining, Saybolt color is frequently used to grade the lightness or darkness of the golden-hued product.

REPEATABILITY

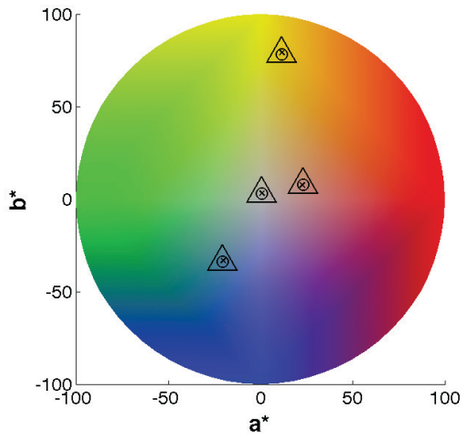

Figure 1: Triplicate measurements (x, O, Δ) of calibrated ceramic color tiles by the Reveal Color Analyzer demonstrate repeatability within 0.4%.

STABILITY

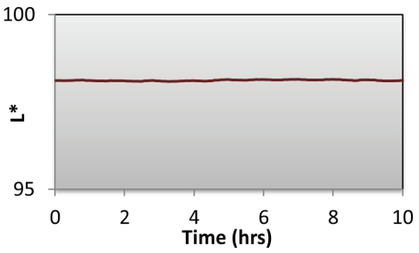

Figure 2: Continuous measurement of CIE lightness (L*) in calibrated ceramic color tile reveals negligible variation, less than 0.02%.

Perhaps the most frequently used color space is that determined by the International Commission on Illumination (abbreviated CIE, after its French title), first defined in 1931 and subsequently revised to yield the CIELAB measurement of lightness and color.

In selecting an industrial color analyzer, there are a number of desired attributes. Versatility to output in a number of color spaces is essential, as the above paragraph describes only three of many desired outputs, which are often standardized by industry or application. Accuracy, precision, and repeatability are paramount to ensure measurement consistency across manufacturing units or facilities. Measurement speed is often critical, guaranteeing that color is monitored as quickly as the product is being produced. And communications to and from the color analyzer are vital for inserting the system into the process stream and plant automation systems. This note describes Prozess Technologie's Reveal Color Analyzer toward these critical quality attributes.

Reveal Color Analyzer

The Prozess contains integrated light sources, either pulsed (xenon) or continuous (xenon, deuterium, tungsten-halogen). Pulsed sources exhibit longer overall lifetimes resulting from a reduced duty cycle, and require active referencing to account for the inherent pulse-to-pulse output variability. Continuous sources exhibit a more stable output after sufficient warm-up time, while their continuous operation reduces their lifetime compared to pulsed sources.

The system contains a sensitive ultraviolet-visible spectrometer with wavelength coverage from 200 to 850 nm with millisecond measurement times. These dispersive spectrometers contain a linear diode array detector and no moving parts for high throughput and maximum stability. The Reveal Color Analyzer contains automated internal hardware for lamp referencing and for wavelength and photometric linearity validation, all of which can be performed at user-defined intervals. Standard communications are used in the system for upstream and downstream interface with distributed control systems, computers or tablets. Sampling options range from flow cells with selectable path lengths, to measuring heads that mate to sight glasses in vessels, to fiber probes for contact or non-contact measurement in various insertion points.

To demonstrate the color measurement abilities of the Reveal Color Analyzer, a fiber optic measurement head with tungsten-halogen illuminator was used to measure calibrated 2" ceramic color tiles. The system was referenced to a 99% reflective diffuse standard. Multiple measurements were obtained from each tile, and measurements were repeated after several hours of instrument shut down and restart. *Figure 1* shows these multiple measurements for each of the white, cyan, magenta, and yellow tiles, demonstrating the unparalleled repeatability and accuracy of the CIELAB measurements. Continuous measurement of a single white tile over multiple hours reveals the stability. As seen in *Figure 2*, the system produces consistent lightness (L*) measurements with variation less than 0.02% over a ten hour span.

Prozess provides a myriad of engineering solutions to integrate into customers' process streams. A wide range of color space outputs, selectable sample interfaces and straightforward communications make the Reveal Color Analyzer ideally suited for rapid integration into industrial process streams.

PROCESS MEASUREMENT
made simple

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